

1/ART.

DEVICE FOR ATTENUATING SOUND ON THE HUMAN EAR

- The invention concerns a device for sound insulation on the human ear
5 according to the introductory part of patent claim 1.

Sleep disturbances or insomnia are an increasing and serious problem in modern times. The average sleeping time has decreased by 30 minutes in the last 20 years. Approximately one in ten people suffers from extreme sleep disturbances which make medical assistance necessary. The treatment of sleep
10 disturbances is mainly in the form of taking sleeping tablets, which firstly is expensive and secondly does not guarantee success and finally may also lead to health damage.

In most cases insomnia has psychological causes. In particular, anxious feelings in many people lead to sometimes chronic sleep disturbances. Apart from
15 mental and physical disorders, another important reason for the occurrence of sleep disturbances lies in the external causes due to noise. This can be firstly noise caused outside the dwelling, for example, street noise. Secondly, noise-related sleep disturbances are due to sounds caused inside the dwelling, for example, sound reproduction equipment, children and other persons. A background of
20 sound persisting for a long time can still lead to (in this case psychological) sleep disturbances even when this disturbance factor has long been eliminated.

Also snoring and breathing which is impaired as a result can lead to sleep disturbances of the snorer. The breathing-related sounds are caused during sleep by flapping movements of the slack soft palate or by the tongue dropping back.
25 Frequently the occurrence of snoring sounds depends on the position of the head during sleep. Lying on one's back during sleep promotes the production of sound.

Third persons too have their sleep disturbed by snoring sounds. During snoring a volume of up to 88 decibels can be reached, which roughly corresponds to the volume of a motor truck driving directly next to the ear.

Various sound insulation means (covering the ears or capable of being inserted in them) are already known, which however are disadvantageous in so far as the sound reduction obtained firstly is not sufficient, and secondly various important sounds such as the alarm of an alarm clock, an alarm system or a telephone or the sounds occurring in case of a break-in are not perceived by the user of the means.

- The sound insulation means already known do in certain circumstances remedy the sound-related sleep disturbances, but are then the cause of sleep disturbances which are caused by anxieties. These include the fear of not hearing
- 10 important sounds. In most cases, therefore, use of the sound insulation means already known is completely dispensed with.

- During snoring the known sound insulation means are unsuitable for remedying the sleep disturbances of the snoring person himself or herself. In some snorers snoring is even assisted by these means, as their own snoring is no longer
- 15 perceived and the snorer is no longer urged to change his or her sleeping position. Impaired breathing then continues to lead to sleep disturbances.

- Also the partners of snorers have very bad sleep disturbances. Use of the means already known for sound insulation is declined for fear of not hearing phases of breathlessness of the snoring partner and then not being able to react in
- 20 case of prolonged cessation of breathing.

- It is therefore the object of the invention to develop a device for sound insulation on the human ear or especially for avoiding sleep disturbances due to noise and other sounds, which on the one hand exhibits good insulation properties and so for example avoids noise-related sleep disturbances, but on the other hand
- 25 prevents important sounds from being missed in spite of the sound insulation measure.

This object is achieved with the characteristics of claim 1. Developments and advantageous embodiments are shown in the subsidiary claims.

The device according to the invention makes it possible to keep any noise away from the hearing organ of the user by means of the two sound-insulating earplugs.

- For the user who suffers from sleep disturbances this means that first of all
- 5 one of the essential causes of sleep disturbances, namely sleep-disturbing noise, is eliminated and deep, refreshing sleep is guaranteed. For users other than those who suffer from sleep disturbances the sound-insulating earplugs according to the invention can also serve to avoid nuisance caused by noise during occupational activity or in leisure time.

- 10 The device according to the invention still allows the user to perceive an alarm or other sound, depending on the event, in spite of sound insulation.

"Depending on the event" means that not every conceivable alarm and/or not every sound is converted to a radio signal and transmitted from a radio station to the radio receiver, for this would impair the desired sound-insulating effect of

- 15 the earplugs.

An event is therefore only a particular alarm or other sound which it is wished to perceive, which is then converted by the radio station to radio signals and transmitted to the radio receiver integrated in the earplug.

- For this purpose the radio station is connected to at least one alarm-
- 20 generating means and/or at least one means which picks up sounds. The radio signal received by the radio receiver is converted in the earplug to audio signals which are perceived by the user. That is to say, in spite of sound insulation the user's attention is drawn to the particular alarm and/or to the particular sound.

As a result, in the case of a user who suffers from sleep disturbances both

- 25 sleep-disturbing noise and other psychologically related causes of sleep disturbances such as the fear of not hearing important sounds are eliminated.

Due to the device according to the invention a large proportion of sleep-disturbing anxieties are reduced, so that very many people can again sleep peacefully and deeply.

In the case of users other than those who suffer from sleep disturbances, due to the device according to the invention in spite of sound insulation their attention can be drawn to an important alarm or a sound which it is wished to perceive during occupational or leisure activity as well.

5 A development provides that the earplug is made of silicone or silicone-like material which is molded or foamed individually in the outer ear and in which the radio receiver with the means for conversion of the radio signals received from the radio station to audio signals is integrally cast or foamed or fitted exchangeably.

10 Due to exact adaptation of the earplugs to the relevant parts of the user's ear, very good sound insulation is achieved. In particular the use of silicone or silicone-like material proved to be highly advantageous for sound insulation and for holding the radio receiver and the means for conversion of the radio signals received from the radio station to audio signals. Here a diaphragm as a means for 15 conversion of the radio signals received from the radio station to audio signals delivers reliable results.

Furthermore it is provided that the nature of the audio signals, in particular the volume, can be specified beforehand.

As a result, the audio signals can be adapted to the individual requirements 20 and preferences of users.

Among the sleeping users and/or users who suffer from sleep disturbances there are for example people who sleep particularly lightly. Here there is the possibility of selecting audio signals with a relatively low volume. Moreover many users of the device according to the invention have more pronounced

25 hearing for very particular sound pitches. Here too suitable adaptations can be made.

Moreover it is conceivable that the device is used in a very sound-intensive environment. As the earplugs damp but do not completely eliminate the sounds occurring there, it is possible to select audio signals which either are very loud or

30 differ suitably from those of the ambient sounds.

An advantageous embodiment of the invention provides that the audio signals reproduce the alarm and/or the sound identically.

This has the advantage that the user of the device according to the invention can immediately associate the perceived audio signals with their origin.

- 5 This is particularly important if the perceived audio signals involve an alarm which must be reacted to as quickly as possible.

Moreover it is intended that the alarm-generating means and/or means which picks up sounds is connected directly or by radio to the radio station.

- As a result, alarm-generating and/or sound-producing means located both
10 very close to the radio station and very far away from the radio station can be coupled to the radio station. Hence it is possible to pass practically any alarm which it is wished to perceive or any sound which it is wished to perceive, to the user of the device.

- Integration of the alarm-generating means and/or means which picks up
15 sounds in the radio station pursues the purpose of reducing the whole device to relatively small dimensions. Advantageously, the device according to the invention can thus be transported and used in any locations.

A development provides that the sound-producing or alarm-generating means is a digital or analog clock with an alarm function.

- 20 Due to this development, the users of the device according to the invention can have the advantages of sound insulation without having to be afraid of missing important appointments.

- In the case of the sleeping persons and/or persons who suffer from sleep disturbances, the sleep disturbances caused by noise and other sounds and the
25 psychologically caused sleep disturbances, which include the fear of missing important appointments, are remedied.

- But also in the case of persons other than those who suffer from sleep disturbances, the most important reason why many people hesitate to use sound-insulating earplugs is also that they are afraid of not hearing the alarm of a clock
30 and so missing important appointments.

Equally, the sound-producing or alarm-generating means can be a telephone, a doorbell station, a baby monitoring device, a smoke alarm or the like device which triggers an audio alarm. Similarly it is provided that the sound-producing or alarm-generating means is the receiving part of a movement detector.

The sound-producing or alarm-generating means which the user of the device according to the invention does not want to sleep through in spite of sound insulation, varies and depends on the user and the field of application.

By using a microphone as a means which picks up sounds it is possible to pick up both generally loud sounds and, in case of corresponding placement of the microphone, separate sounds which occur only at very particular locations.

Depending on the event, corresponding sounds are then transmitted as a radio signal to the user of the device.

Events which it is wished to perceive in the case of sleeping users of the device and/or users who suffer from sleep disturbances, can be for example the sounds produced by a burglar. When normal earplugs are used, these sounds can very easily be missed.

A development provides that between the means which picks up sounds and the radio station is arranged a means for recognition of the sounds picked up and that by means of recognition only certain sounds which can be specified beforehand are transmitted from the radio station to the radio receiver.

As a result, out of a plurality of possible sounds, only certain sounds which it is wished to perceive are recorded by the user of the device.

As a means for recognition of the sounds picked up, a hardware-assisted and/or software-assisted speech and snoring recognition system is possible.

Hence it is for example possible to store very many sounds which it is wished to perceive such as speech or snoring. When the sounds picked up match the sounds stored, corresponding radio signals are transmitted to the radio receiver.

In the case of a snoring person who uses the device according to the invention, snoring can be an event which leads to corresponding radio signals being transmitted to the snorer and converted to audio signals. The snorer consciously or unconsciously perceives these audio signals, and stops snoring by

- 5 altering his or her sleeping position, for example.

A development provides that the audio signals are so loud that the snorer is woken up or at least urged to change his or her sleeping position.

An advantageous embodiment pursues the purpose that the device can be used by several users simultaneously, wherein each user has two sound-insulating

- 10 earplugs and in at least one of the earplugs is integrated a radio receiver with a means for the conversion of radio signals received from a radio station to audio signals.

Such a development is sensible in the case of groups of persons who spend the night, work or arrange their leisure in the same rooms or dwellings.

- 15 Moreover it is possible that, by the means for recognition of the sounds picked up, it can be specified beforehand to which user of the device a particular sound picked up is to be transmitted.

Particularly in the case of snoring persons who affect each other with their snoring sounds, the device is suitable for deliberately transmitting to the

- 20 originating snorer after recognition an audio signal or his or her own original snoring sound, so that he or she stops snoring.

Preferably a miniature radio receiver is to be used as the radio receiver.

Hence particularly small embodiments of the earplugs are possible, so that the earplugs are not felt to be foreign bodies.

- 25 Below, the invention is described with the aid of a practical example which is shown in the drawings. They show:

Fig. 1 a schematic view of the device according to the invention for sound insulation on the human ear,

Fig. 2 a block diagram of a radio station, and

- 30 Fig. 3 a block diagram of a miniature radio receiver.

The device for sound insulation on the human ear shown in Fig. 1 includes two earplugs 10, 12 in each of which is integrated a miniature radio receiver 14, 16. Each earplug 10, 12 is made of silicone and individually adapted to the shape of the relevant parts of the ear of the respective user, as the silicone is foamed in 5 the external ear. By this means and by the sound-insulating effect of silicone it is ensured that no disturbing sounds can be picked up by the hearing organs of the user of the device according to the invention.

The miniature radio receivers 14, 16 foamed integrally in the earplugs 10, 12 trigger, after the reception of a radio signal by means of a transducer, certain 10 audio signals which are perceived by the hearing organs of the user.

Fig. 2 shows a block diagram of a radio station 18 with a modulator 40, an electronic switch 42, a transmitter 20, preferably for the giga-hertz range, and an aerial 44. In the radio station 18 are integrated a clock 22 with alarm function and a microphone 36. Between microphone 36 and modulator 40 is arranged a means 15 for sound recognition 38 of sounds picked up. Moreover in the radio station 18 is arranged a receiving part 26 for external alarm modules. As an example, a movement detector 24, a telephone 28, a doorbell station 30, a baby monitoring device 32 and a smoke alarm 34 are shown and connected. A connection can also be made wirelessly by a radio, infrared or ultrasound section.

20 Fig. 3 shows a block diagram of a miniature radio receiver 14, 16 as arranged in the earplugs 10, 12. Each miniature radio receiver 14, 16 includes an aerial 46, a receiver 48 for the giga-hertz range with a demodulator 50, an amplifier 54, an electronic switch 52 and a sound transducer 56. The received demodulated audio signals are thus converted to audio signals after amplification 25 by the sound transducer 56. The electronic switch 52 serves to mute the amplifier 54 when no signal is received from the radio station 18. Thus disturbing noise is suppressed.

When the device according to the invention is used for sound insulation on the human ear, the miniature radio receivers 14, 16 are located within reception 30 range of the radio station 18. If a certain wake-up time is set at the clock 22, a

wake-up signal is transmitted from the radio station 18, picked up by the miniature radio receiver 14, 16 and converted by the sound transducer 56 to an audio signal which is perceived by the ear.

- For a sleeping user of the device according to the invention and/or one who
- 5 suffers from sleep disturbances, in this way it is possible to sleep deeply and undisturbed, that is, without any noise influence, and yet to be woken up reliably by the wake-up call of the clock 22. Also sleep disturbances caused by anxieties, for example the fear of sleeping through an important appointment, are eliminated by this means.

- 10 The radio station 18 is further coupled to the receiving part 26 for different alarm modules. This can be a movement detector 24. In case of unauthorized opening of a door or window or movements by unauthorized persons, a signal of the movement detector 24 is picked up by the receiving part 26 and transmitted to the radio station 18. Thereupon a specific radio signal is emitted by the radio
- 15 station 18 via the transmitter 20, received by the miniature radio receiver 14, 16 in the earplug 10, 12 and converted to an audio signal for the sleeping user.

- Similarly, sounds which are produced by a telephone 28, a doorbell station 30, a baby monitoring device 32 or a smoke alarm 34 can also be converted to corresponding radio signals. Also sounds which are caused by a burglary of a
- 20 dwelling and picked up by the microphone 36 integrated in the radio station 18 can be converted to corresponding radio signals. These radio signals are then picked up by the miniature radio receiver 14, 16 and there converted to an audio signal or wake-up signal which can be perceived by the user. An electronic switch 42 serves to switch on the transmitter 20 only when sounds or alarm are to be
- 25 transmitted to the miniature radio receivers 14, 16.

The device according to the invention is further particularly well suited to the elimination of sleep disturbances caused by snoring.

- By a means integrated in the radio station 18 for picking up sounds, the microphone 36, the snoring sounds of the snorer using the device are picked up. If
- 30 snoring is an event which can be specified beforehand and which can be evaluated

separately and identified, then a radio signal is transmitted from the radio station 18 to the miniature radio receiver 14, 16 of the snorer. The snorer perceives the corresponding audio signals. The volume of the audio signals is selected for this case such that the snorer is either woken up or urged to change his or her sleeping 5 position and so stop snoring.

Apart from artificial sounds, the original snoring sounds can be reproduced identically as the audio signals, so that the snoring person hears his or her own snoring in a kind of sound feedback and interrupts the snoring process.

It turned out that in case of frequent use of the device according to the 10 invention the snorer is sensitized accordingly and automatically adopts a sleeping position with no risk of snoring when he or she falls asleep.

To check whether snoring or another sound is an event, between the microphone 36 and the modulator 18 is arranged a sound recognition system 38. The sound recognition system 38 can in this case also be integrated in the radio 15 station 18. Due to recognition, only certain sounds which can be specified beforehand are transmitted from the radio station 18 to the radio receiver 14, 16.

This purpose is served by a hardware-assisted and/or software-assisted speech or snoring recognition system integrated in the radio station. The snoring sounds picked up can thus for example be associated with their originator in order 20 to cause, on renewed snoring, the transmission of these sounds to the miniature radio receiver 14, 16 of the snoring person. Hence snoring is already stopped early on.

In case of several users of the device, by means of the hardware-assisted and/or software-assisted speech or snoring recognition system it is of course also 25 possible to transmit radio signals only to the user who causes snoring sounds.

Moreover, by means of the device according to the invention the sleep disturbances of the partners of snorers are remedied. They decline to use the known sound insulation means for fear of missing phases of breathlessness of the snoring partner and then not being able to react in case of prolonged cessation of 30 breathing. By means of the hardware-assisted and/or software-assisted speech or

snoring recognition system it is possible to measure the periods of time between individual snoring sounds and so monitor the breathing of the snorer. In case of a life-threateningly long cessation of breathing there would then be the possibility of giving the partner of the snoring person the alarm by an audio signal.

- 5 It goes without saying that the earplugs 10, 12 according to the invention can also be used by non-sleeping persons independently of the radio station 18, in order to obtain protection against noise in case of severe noise pollution during leisure time or occupational activity. In connection with the radio station 18 described above, certain signals, for example warning signals in construction
10 work, can nevertheless be heard by the persons shielded against the effect of noise.

The invention is not confined to the practical example described above. On the contrary, numerous modifications are conceivable within the scope of the basic concept of the invention which consists of the provision of sound-insulating
15 earplugs 10, 12 provided with a miniature radio receiver 14, 16 which can receive particular event-related signals from a radio station 18 and generate particular audio signals in the ear, the radio station 18 being connected to alarm-generating means and/or means which pick up sounds 24-34.

Target groups are, amongst others, all night-shift emergency services,
20 prison staff, fire brigade, nurses, doctors, other care services, security services, police, disaster prevention associations, armed forces units, reserve services of all kinds or all day-shift persons who are subjected to an elevated noise level.